TeleMed: A High Performance Distributed Application for the Real World

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What's Coming

- Motivation
- Components of Technology
- Application to Medicine
- TeleMed Demonstration between LANL/ACL and LLNL
- Technology Architecture
- Application to Manufacturing
- Lessons Learned

Integrated Applications in the Sunrise Project

- Telemedicine (TeleMed)
- Materials modeling analysis
- Manufacturing technologies
- Engineering design tools
- Environmental Management

Sunrise: an Integrated Approach to the NII

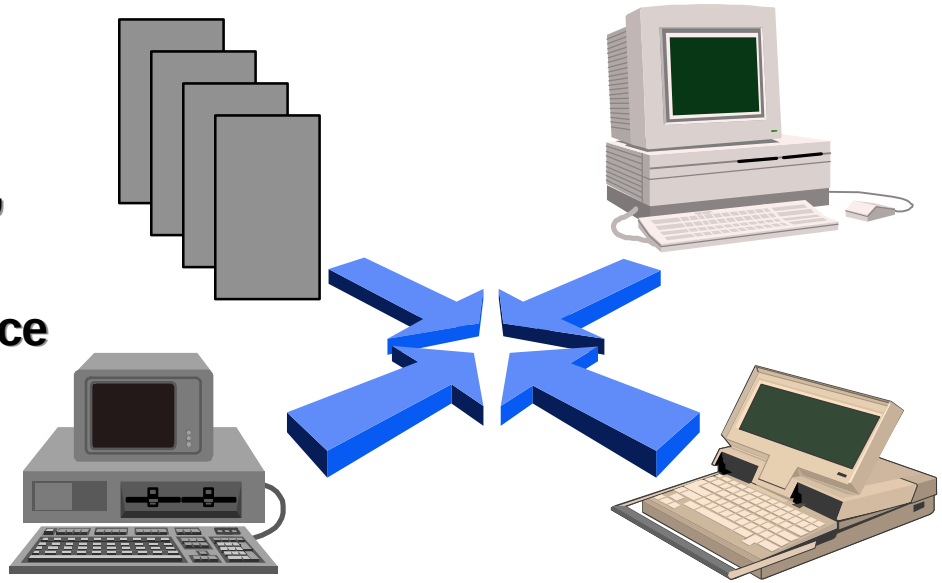
- **Need: Scaleable, extensible architecture for the National Information Infrastructure which works for industry**
- **Objectives:**
  - **Develop common information-enabling tools for advanced scientific research and its application to industry**
  - **Enhance the capabilities of important research programs at the Laboratory**
  - **Define a new way of collaboration between computer science, and industrially relevant research**

Sunrise: An Integrated Approach to the NII

- Build on HPCC strengths at LANL
  - Develop HPCC as a commodity service
- Use application suite to define infrastructure
- Design reusable components that span many disciplines:
  - e.g., CFD simulation to telemedicine
  - data-mining is common to wide variety of problems
- Use industrial standard, interoperable components wherever possible
- Build on network which provides high-bandwidth, multimedia for the future
- Live with existing bandwidth when necessary

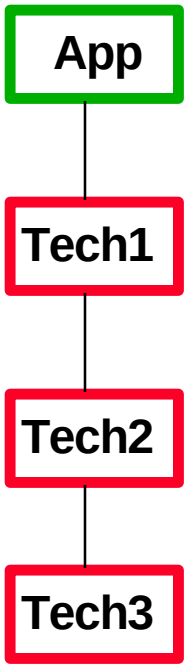
The Problem of Integrating Applications

- ***Application Integration*** **and** ***Distributed Processing*** **are the same thing:**
- **Constructing information-sharing distributed systems from diverse sources:**
  - ❑ **heterogeneous,**
  - ❑ **networked,**
  - ❑ **physically disparate,**
  - ❑ **multi-vendor.**
  - ❑ **disparate performance**



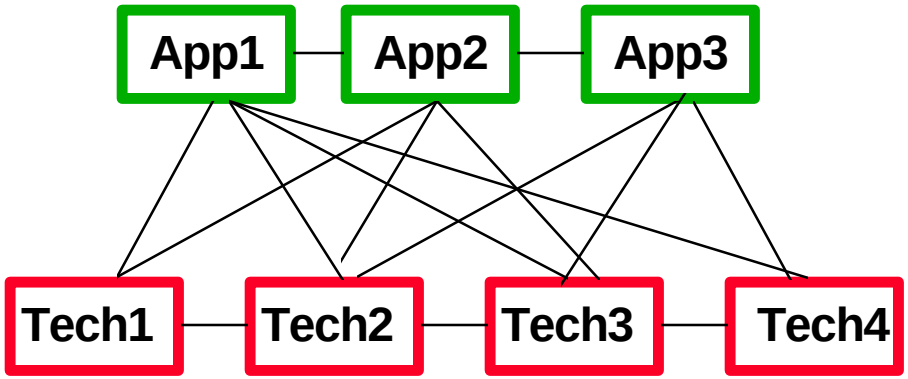
Sunrise Approach

Vertical Integration



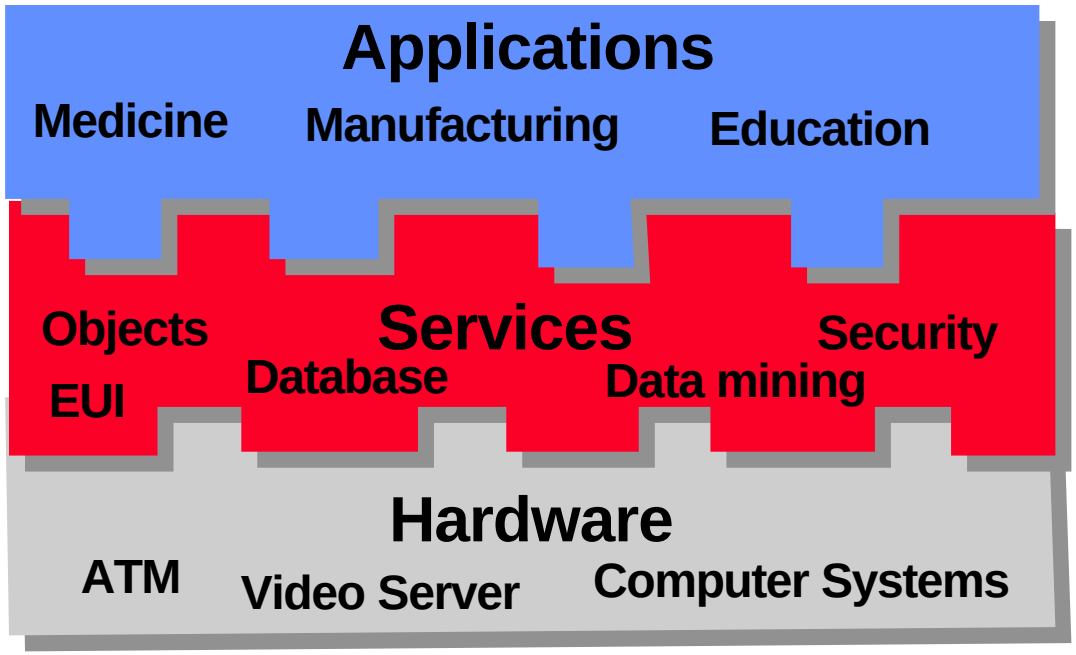
- Efficient for given domain
- Not always scaleable

Horizontal Integration



- Common tools identifed
- Infrastructure clearly delineated
- Scaleable solutions

Sunrise uses an Integrated, Layered structure

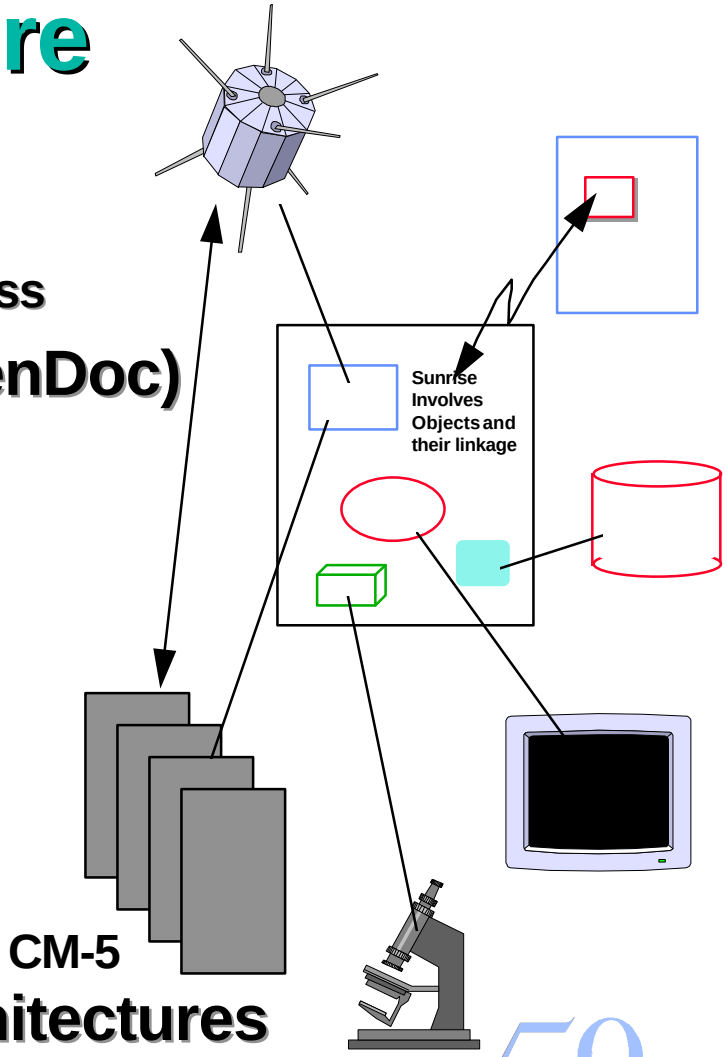


Integration Infrastructure

- Distributed Object Computing
- User Interface and Telecollaboration
- Data Analysis and Visualization
- Data Mining
- ATM Networking
- Security

Reusable, Extensible Infrastructure

- Distributed Object System
  - Dynamic, hierarchical, desktop access
- Document interface (e.g., OpenDoc)
  - Nested, remote objects
  - Extensible
  - Heterogeneous platform support
  - Can link to scientific application
- Multimedia support (ATM)
- Security for each object
- Telecollaboration
- Spans multiple hardware architectures



Distributed Object Development Environment

- Portable Object Foundation Classes
- Implemented on workstations, parallel machines, clusters, and vector supercomputers (operational on Sun, Cluster, CM-5, T3D)
- Efficient, portable IO Framework
  - Data written on CM-5 SDA read on Cray, workstation
  - Transparent archiving
- Application specific objects built on top of these: Particle simulation, teleradiology, Clustering algorithms
- Analysis and visualization classes (under development)

POOMA Framework

Applications

- Xerography
- Medical Imaging
- Numerical Tokamak

Application Components

- Field Solver
- Krylov Solver
- Particle Advector
- N-Body Forces
- Clusters

Global

- I/O
- Particles
- Field
- Matrix
- Interpolate

Parallel Abstract

- Comm
- Vnode
- Balancer
- Layout Manager
- Data Layout
- UDO

Local

- L I/O
- LParticles
- LFields
- LMatrix
- LInterpolate

User Interface and Telecollaboration

- Need for a media-rich flexible user interface that can provide the information in an intuitive and extensible manner
- Support for video, sound, and distributed data sources required
- Gain Momentum has been used because of its flexible, object-oriented support of multimedia.
- An executive user interface for computerized patient records has been developed
- Logbook capability is in development
- Wide World Web used for project communication

Security

- Goal: Provide capability for authentication and authorization to view distributed data
- Secure data at object level, allow policy to drive security deployment
- Developed Kerberos-like public-key based key and ticket server system for use with CORBA
- Developed a scheme to secure remote C++ method calls in CORBA applications

Data Mining

- Large data sets need computational assistance for analysis
- General concept extraction techniques including
  - image comparison and matching
  - multi-dimensional cluster analysis
  - wavelet transform for variable granularity display
  - multi-dimensional database navigation
- Deliver these technologies in a usable, scaleable environment

Medical Information

- The National Information Infrastructure (NII) will have a profound effect on the way in which medical data is utilized.
- A patient's medical history be immediately available to a physician anywhere in the country within seconds, and this history will contain
  - text (physician notes from every office visit),
  - numerical data (height, weight, blood pressure),
  - digitally recorded signals (erratic heart sounds, EKG traces),
  - and digital imagery (photographs, x-rays, MRI scans).

TeleMed

- We have developed a prototype software environment for a physician
  - relevant information is available and easily manipulated.
  - displays and analyze imagery,
  - manage patient records,
  - provide easy data entry,
- Transparent access to information located anywhere on the massive *information superhighway* will give doctors great flexibility in their work

Utilize Distributed Architecture to Aid Healthcare

- Provide rapid access to full patient record
- Compare to treatment of similar patients
- Allow remote doctors to view and collaborate on patient record
- Powerful tool in saving physician time and providing more precise diagnosis and clinical analysis

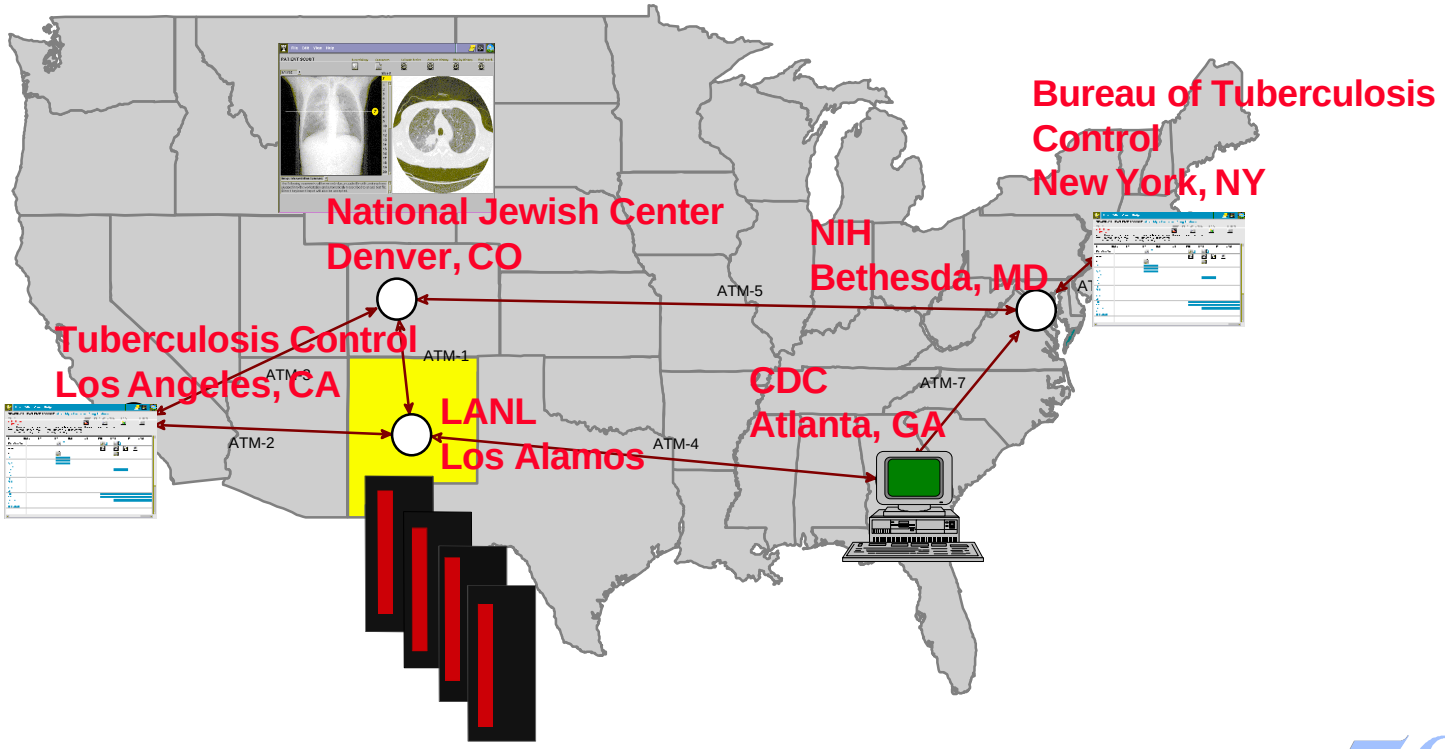
TeleMed Demonstration

- Application interface (Gain Momentum) installed on this SGI
- ORBIX Object Request Broker at two sites
- MedLib and MatchLib running in the LANL/ACL on a 4 processor SGI Power Challenge
- System attaches to Object servers and brings data on demand

TeleMed is built on Open Distributed Object Technology

- CORBA/ORB's for communicating between systems
- Multimedia graphical interface including audio
- Patient data stored in OODBMS's
- Scalable concept extraction techniques
- Object level security and authentication
- All objects are fully distributed

Sunrise TeleMed Network



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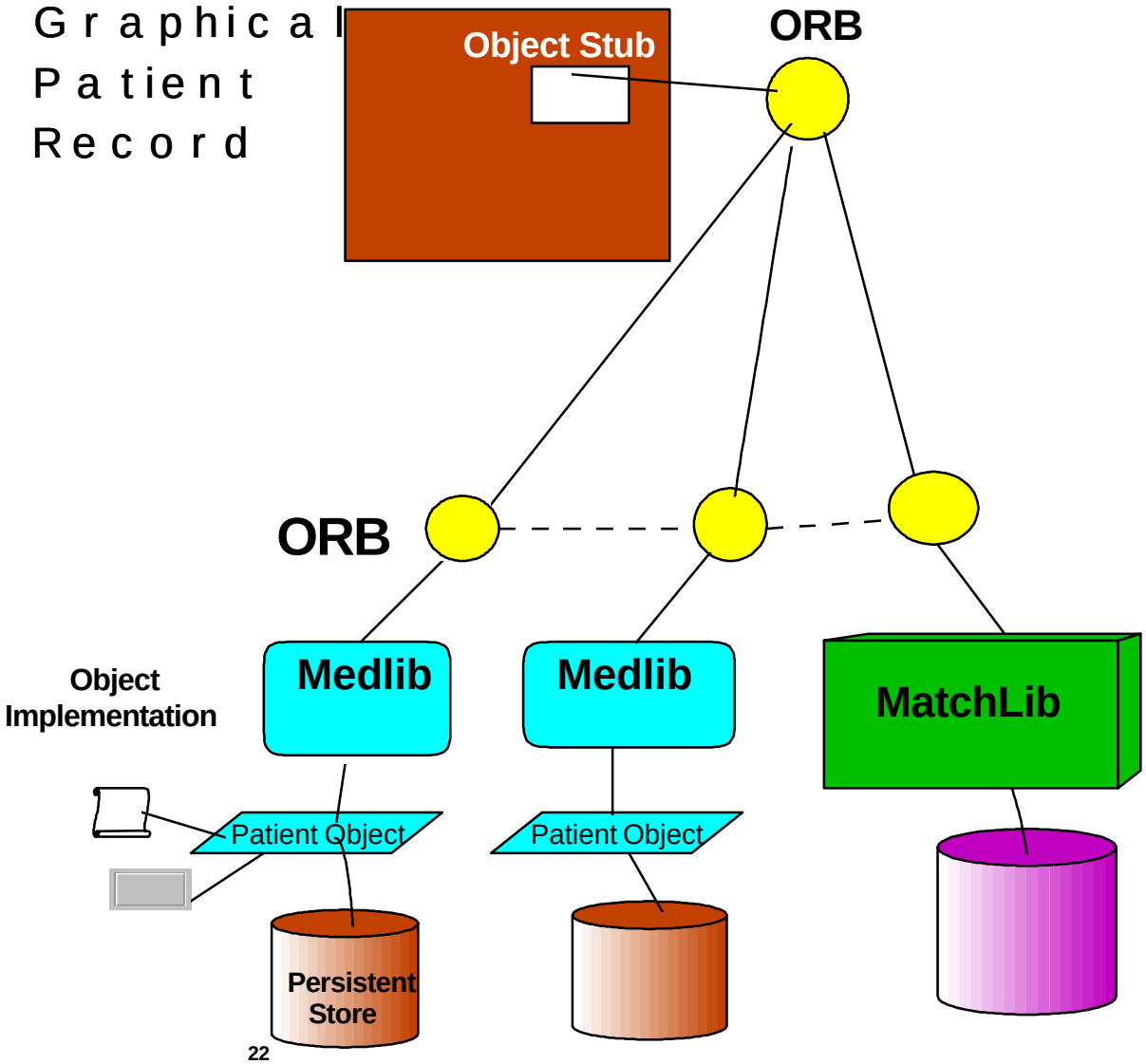
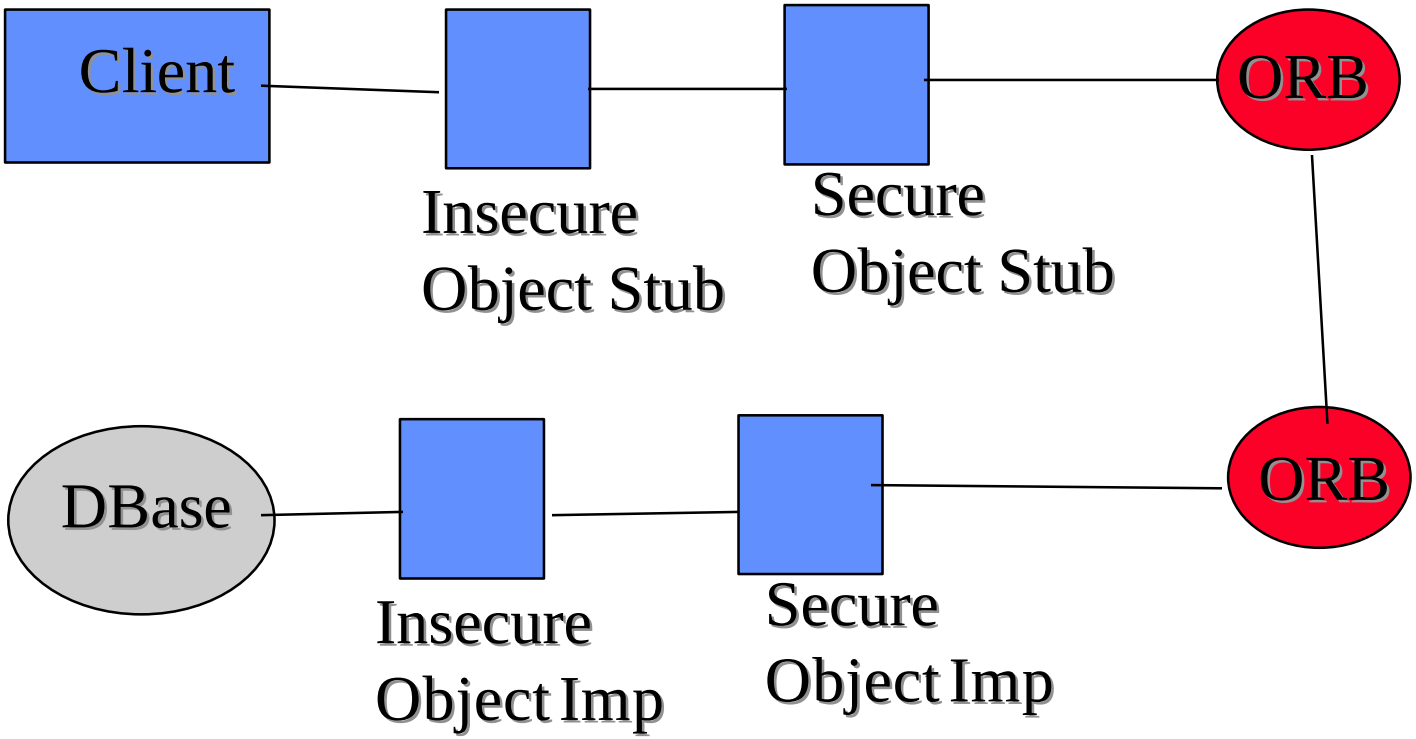
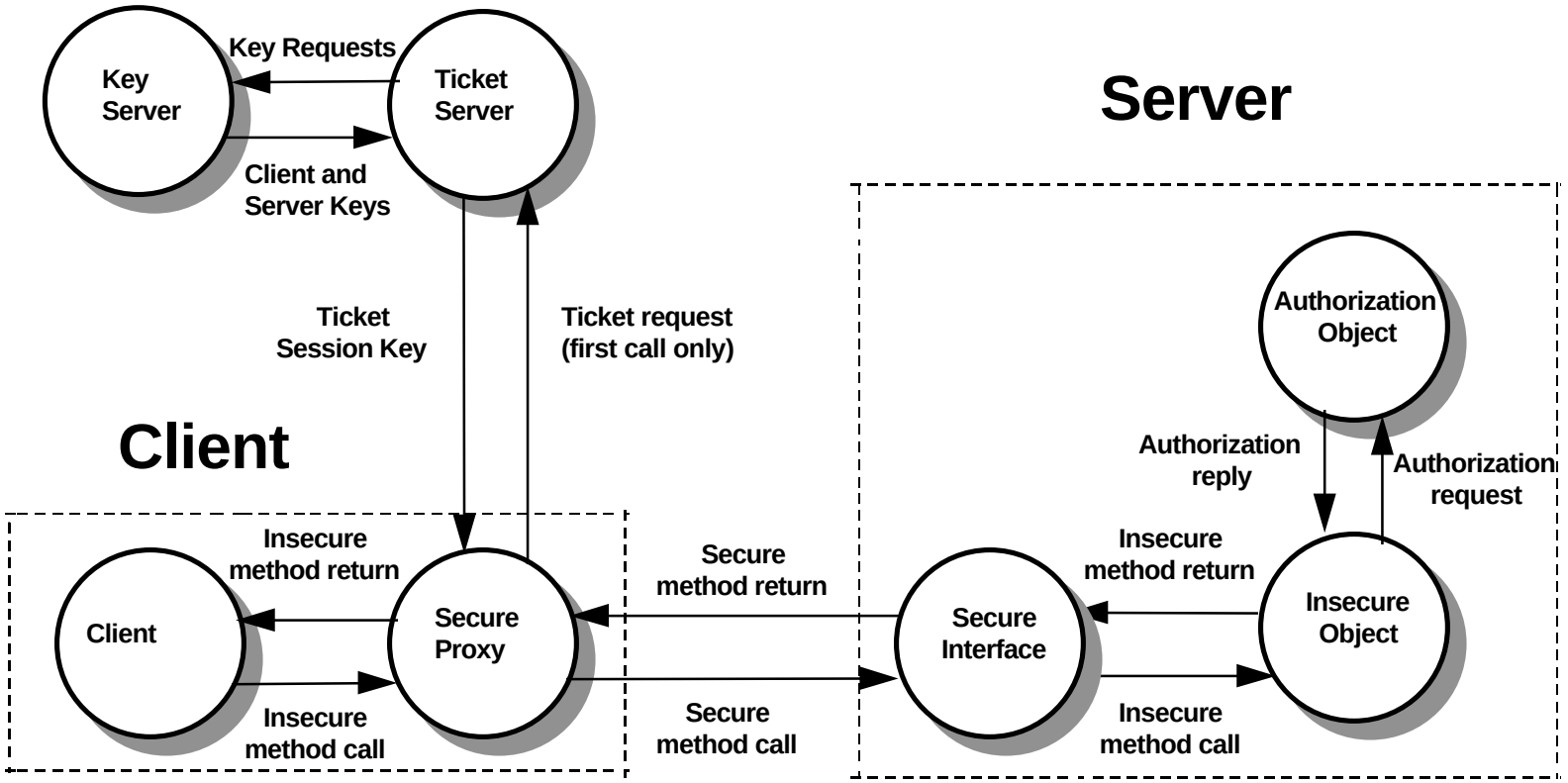
TeleMed Architecture



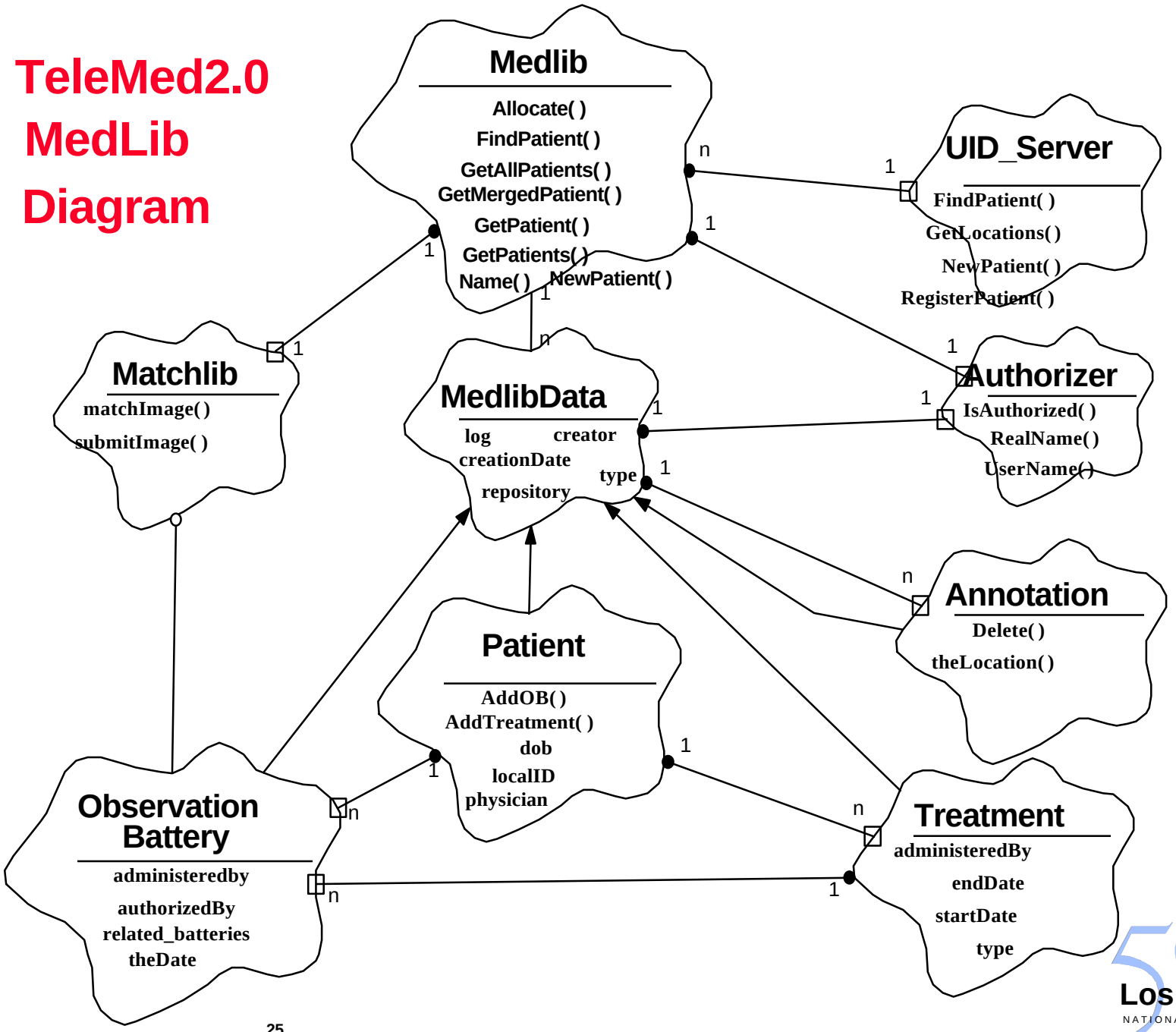
Security in TeleMed



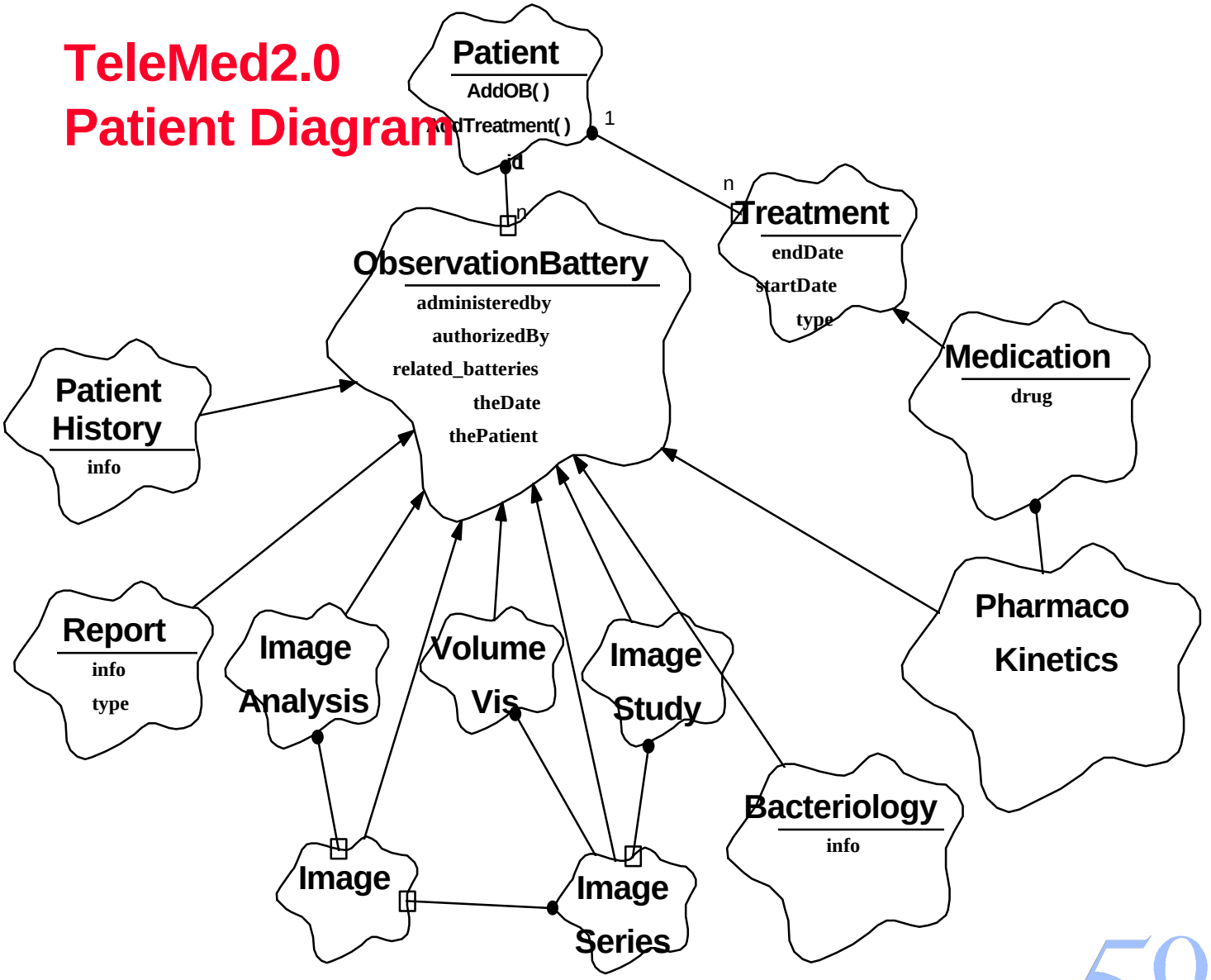
TeleMed Security Infrastructure



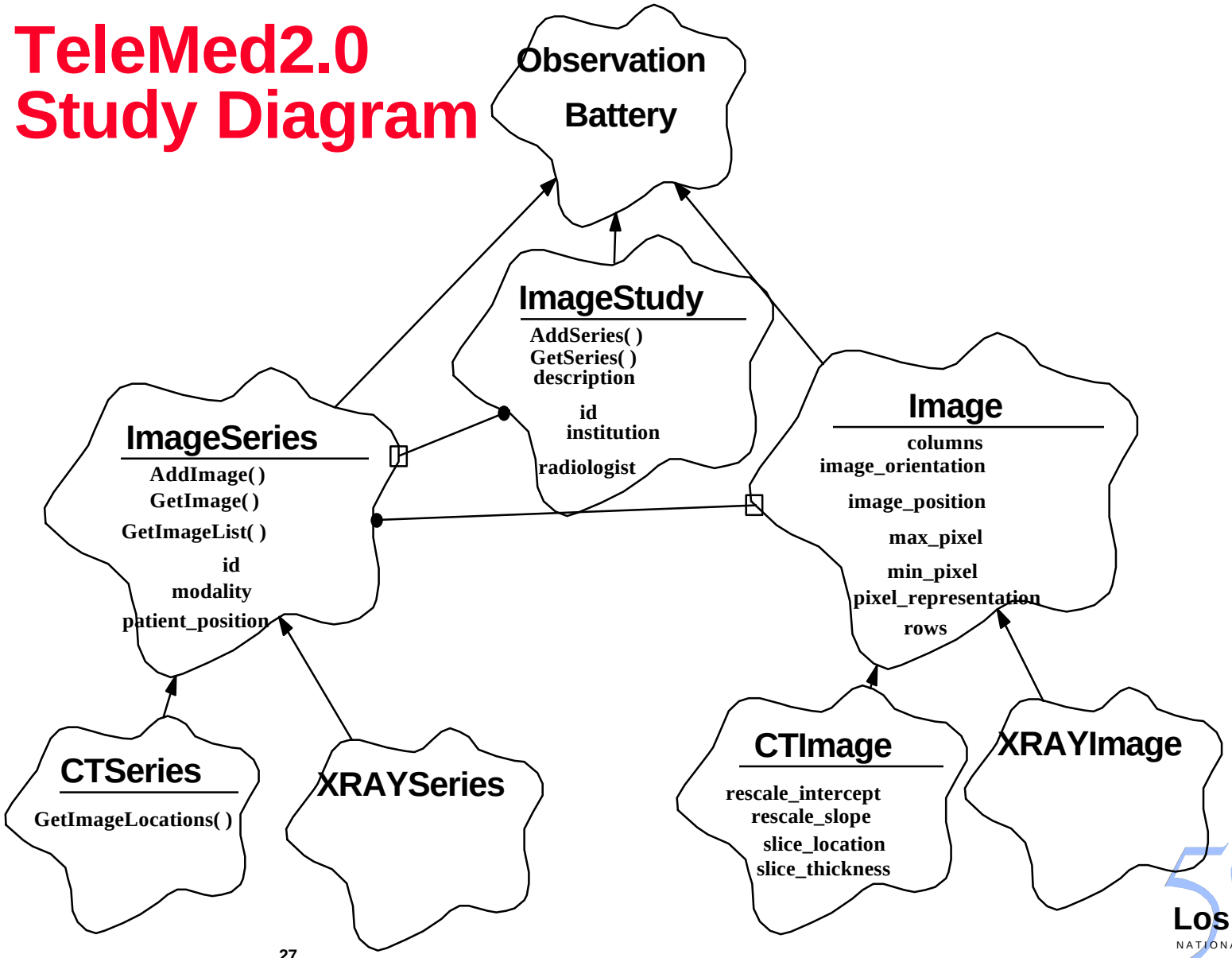
TeleMed2.0 MedLib Diagram



TeleMed2.0
Patient Diagram

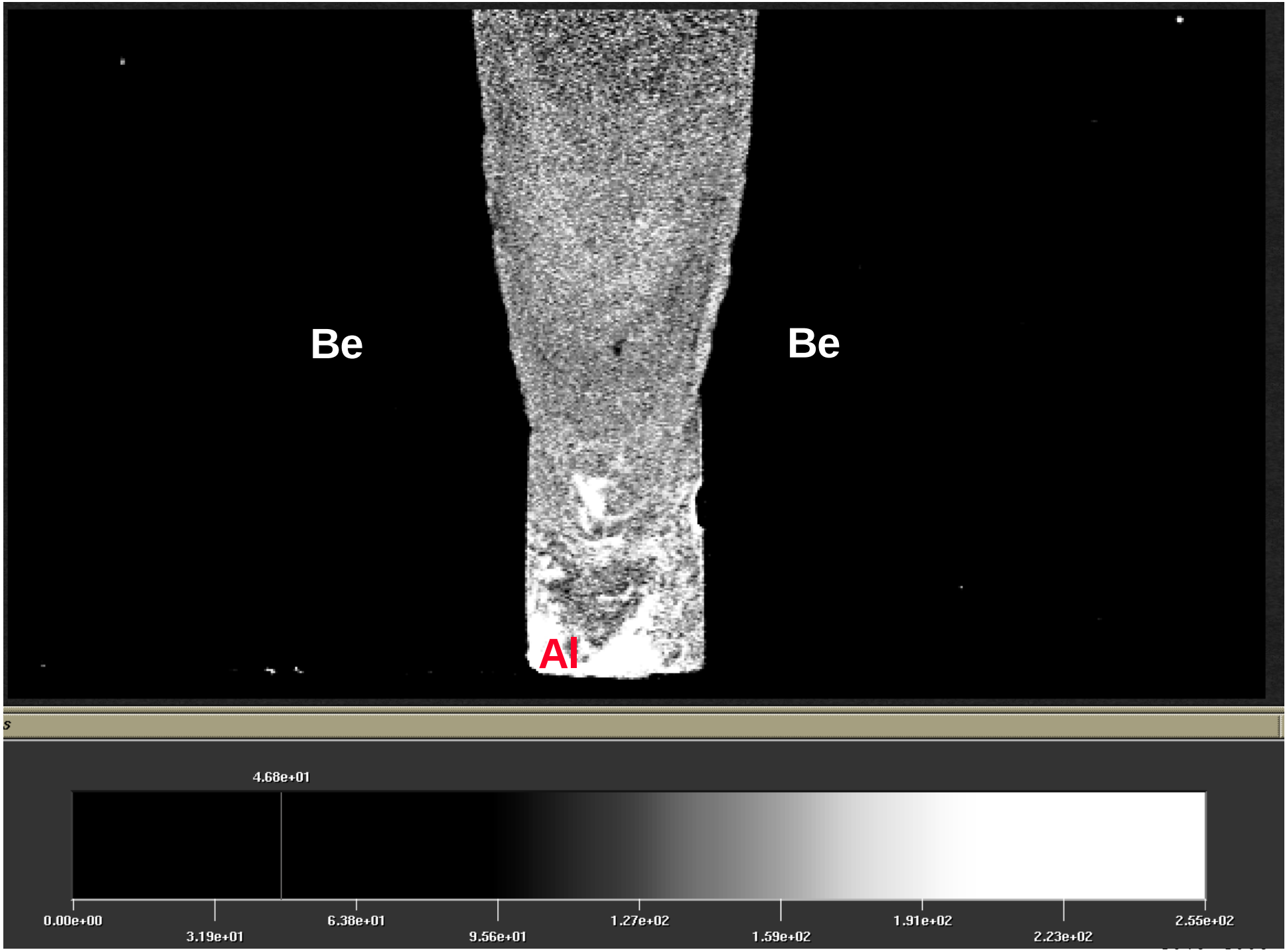


TeleMed2.0 Study Diagram



TeleMed and Manufacturing

- "Patient" data exists in Manufacturing:
  - We must keep track of large amounts of information selectively and intelligently for a system over time
  - We must be able to determine relationships between textual, image, and other engineering data
- We are beginning support for microstructure of materials used in manufacturing:
  - Characterize structures of welds created with electron beams and laser beams, using x-ray tomography, e.g.
  - Characterize structures of a variety of data generated by SEM and TEM instruments
- Surveillance of full engineering systems to determine history and current usefulness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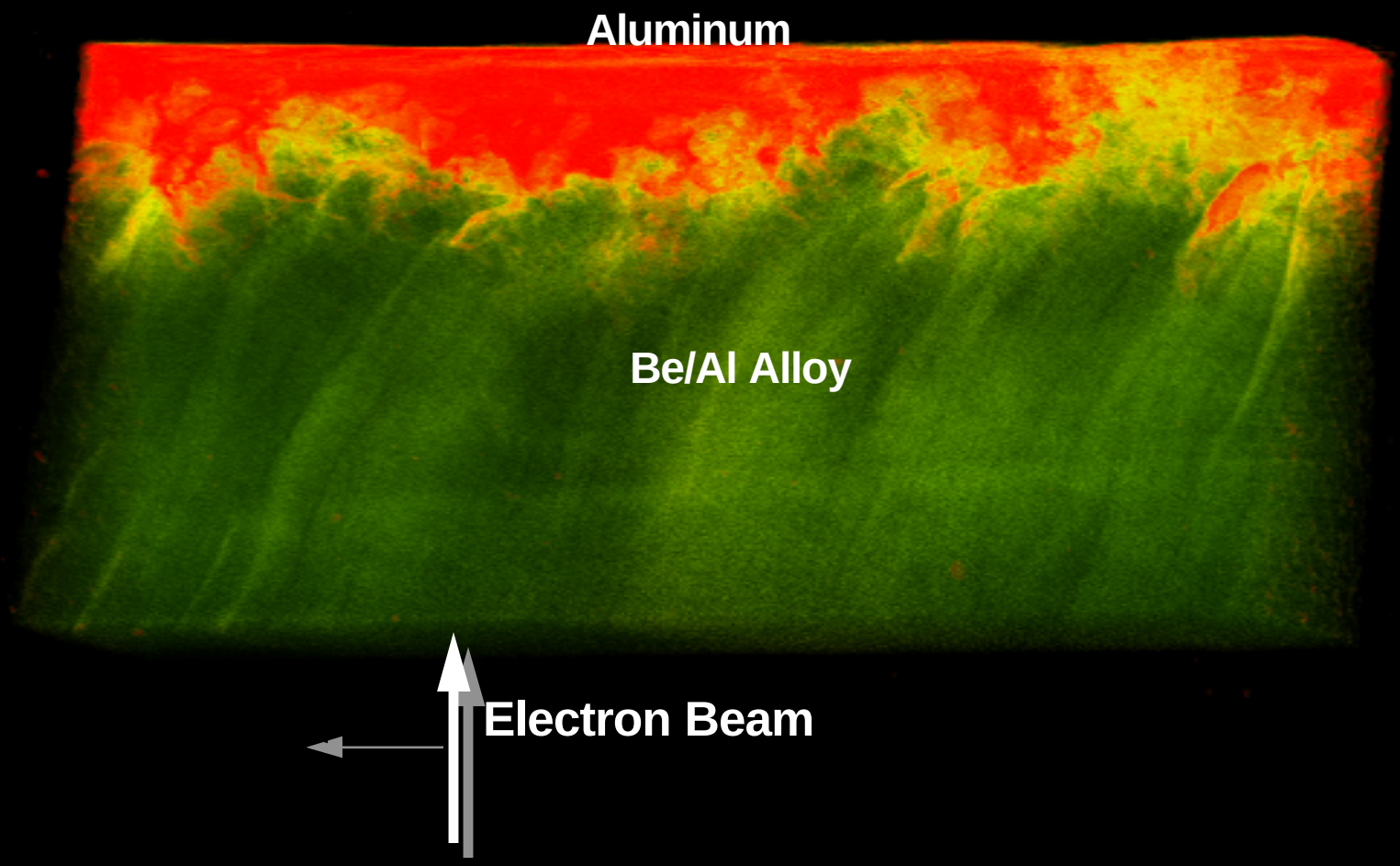
Beryllium/Aluminum Weld



Information Infrastructure will Change Manufacturing Methodology

- Electronic Commerce (EDI)
- Support virtual corporations with distributed assets
  - Provide access to distributed databases
  - Data Mining on corporate knowledge
- Enhance ability to select and discriminate between advanced manufacturing technologies
- Better understand collections of integrated systems and how they function
  - Compare designs with functioning systems
  - Facilitate necessary retrofits, etc. only as needed

TeleMed Emphasizes Technology Reuse

- **Image Browsing tools**
  - Feature extraction works for materials, medical images, financial data, transportation networks
  - Extension of feature extraction to other domains
- **Standardized base objects**
  - Common elements such as signatures, image, embeddability
  - Portable across systems and storage technologies
- **Navigation tools**
  - Location finding, object name resolution, network display
  - Log books, secure time stamps
- **Digital video might be computer output or instrument output**
  - Data fusion combines different types of data

Sunrise Futures

- Add embedded video teleconferenceing software for tele-collaboration so that data can be annotated in a “shared” manner.
  - Store video data with other data
- OpenAPI for connect a variety of additional analysis tools.
- Extended query capability.
- Deploy full software in an engineering environment.

Database Support Requirements for TeleMed

- Extensible data types
- Extensible Data Access Methods
- Query by Content
- Robust Database Management Functions
- Support for SQL and relational tables
- Heterogeneous Data Access
- Multiple Interfaces to Databases
- Tools for display of Data

Significant Results from TeleMed

- Powerful intuitive interface
  - Easy access to any patient data
  - Entire treatment history visible (collects all relevant factors for proper management of disease)
- Ability to reduce treatment costs and improve patient care
- Integration of multimedia data from a variety of sources is useful in many applications
- Data mining techniques can be used by non-technical users
- Truly practical use of distributed HPC.

Sunrise/TeleMed Team

- Dick Phillips, TeleMed project leader
- Jim Cook, John Newell, Physicians NJC
- Bob Tomlinson, Distributed Computing
- Jonathan Greenfield, Security
- Pat Kelly, Data Mining (CANDID)
- Al McPherson, Visualization
- John Reynders, Parallel Objects
- Jonathan Bradley, Compression
- Steve Tenbrink, Networking
- Mohamad Ijadi, Dave Kilman Software integration
- Juhnyoung Lee, Francisco Reverbel: OO Databases
- Jim George, Scanning platforms

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